Processing of Text Documents for Subsequent Semantic Analysis

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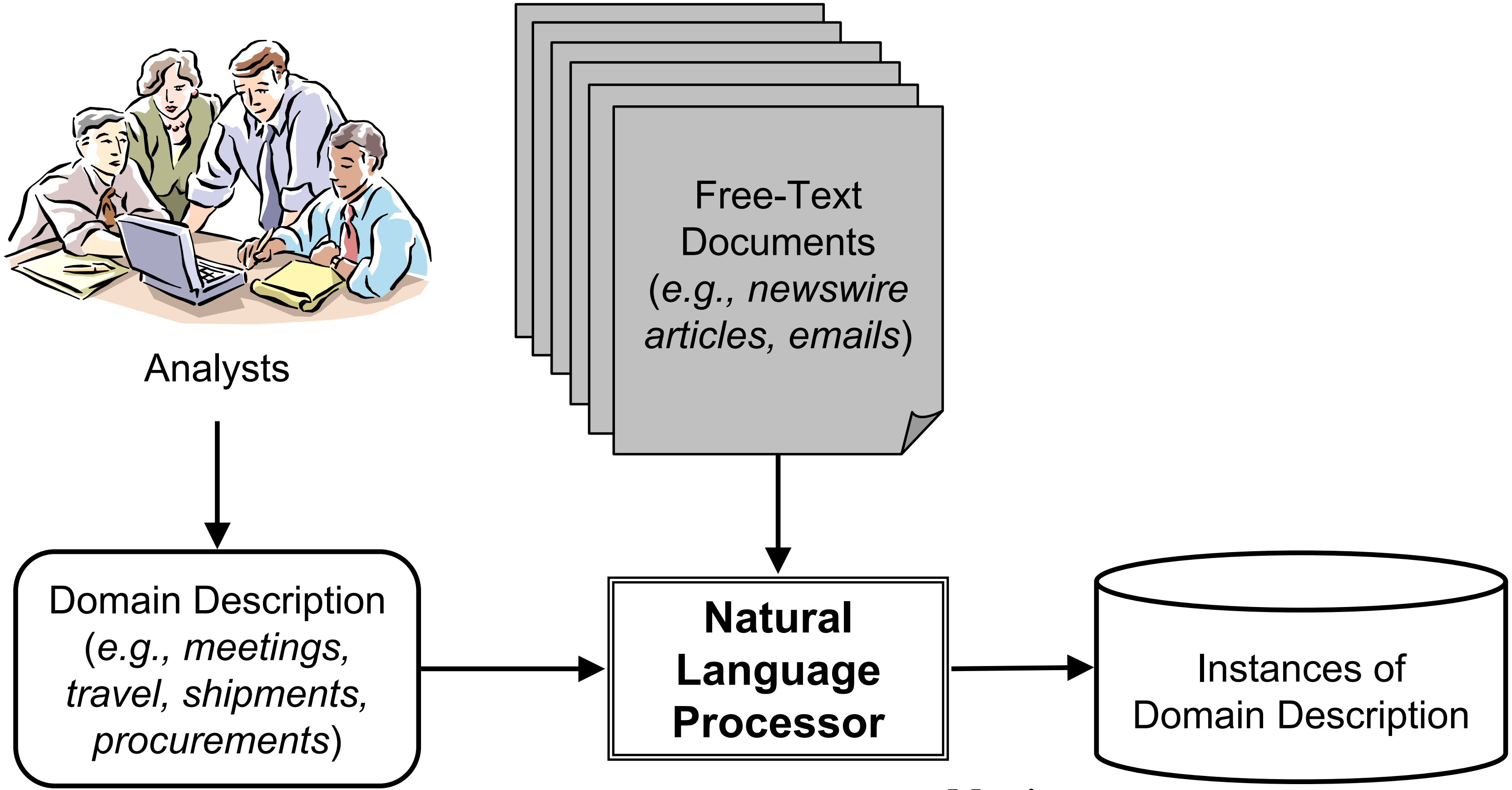
Manually reading all available and relevant textual information is daunting!!



Analysts

Free-Text Documents (*e.g., newswire articles, emails*)

Domain Description (*e.g., meetings, travel, shipments, procurements*)

Natural Language Processor

Instances of Domain Description

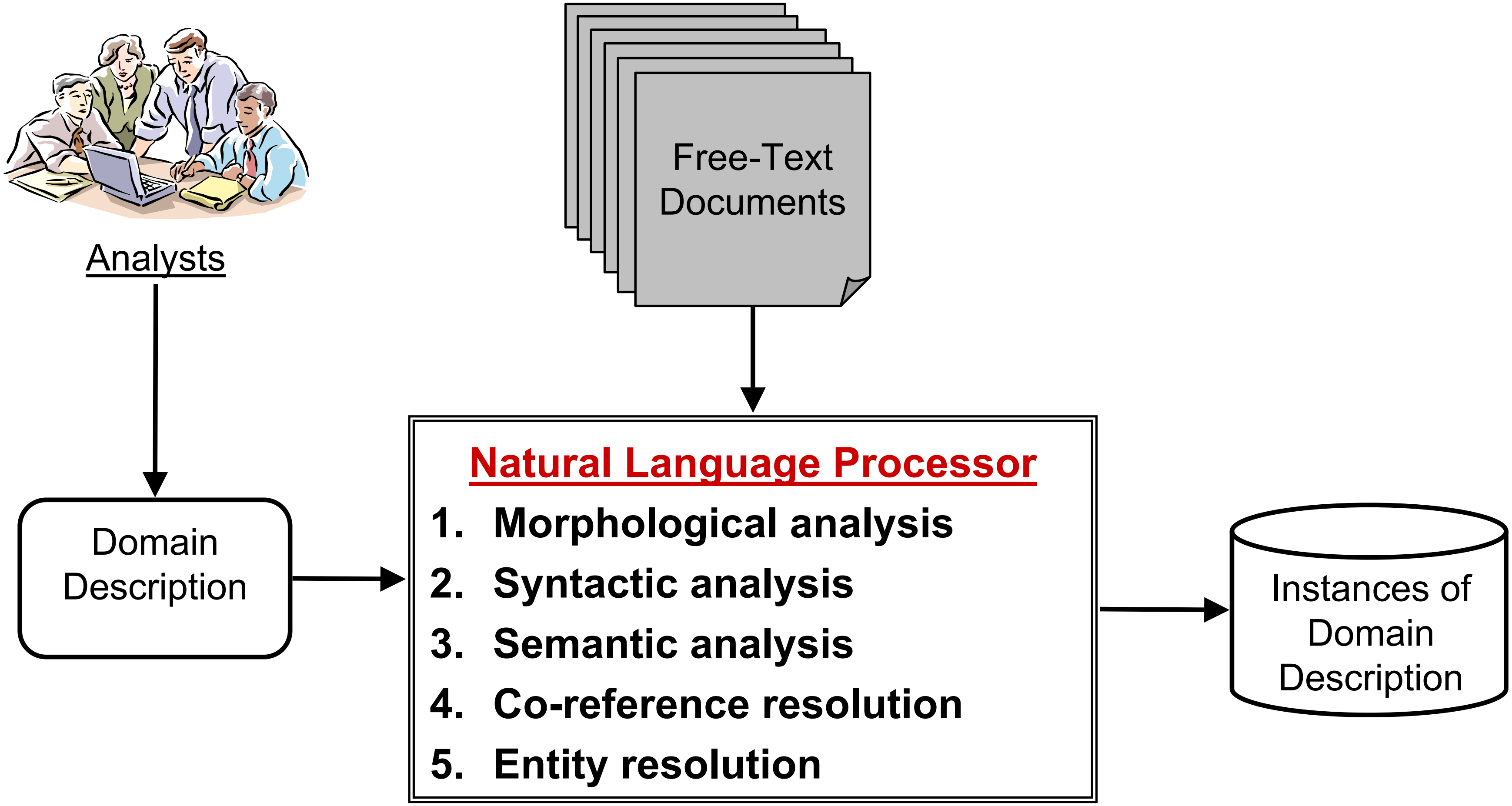
Meeting

***Document ID*:**	**1**
***People*:**	***John Smith, Jane Adams***
***Location*:**	***Livermore, CA***
***Purpose*:**	***DHS***

Relevance to Homeland Security

- Our sponsor is LLNL’s Information Operations Assurance Center (IOAC) .
  - IOAC is part of LLNL’s NAI directorate.
  - Our point of contact is Everett Wheelock.
  - This work helps IOAC in their text analysis tasks by automatically generating semantic data structures from free-text.
- We started this project on February 17, 2004.
  - Mike Firpo: 50%
  - Tina Eliassi-Rad: 5%

Steps in Natural Language Processing for Information Extraction



Analysts

Free-Text Documents

Domain Description

Natural Language Processor

1. **Morphological analysis**
2. **Syntactic analysis**
3. **Semantic analysis**
4. **Co-reference resolution**
5. **Entity resolution**

Instances of Domain Description

Morphological Analysis

- Individual words are analyzed into their components.
  - Example: The word "John's" is pulled apart into the proper noun "John" and the possessive suffix "'s".
- Non-word tokens, such as punctuation, are separated from the words.
  - Example: "John got a 5% raise." becomes "John got a 5 % raise ."

Natural Language Processor

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Syntactic Analysis

- **Linear sequences of words are transformed into structures that show how the words relate to each other.**
  - **Example: "I saw Smith." is transformed into (S (NP (PRP I)) (VP (VBD saw) (NP (NNP Smith))) (. .)).**

Natural Language Processor

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Semantic Analysis

- The structures created by the syntactic analyzer are assigned meanings.
  - A mapping is made between the syntactic structures and objects in the task domain.
  - Example: Syntactic analyzer outputs (S (NP (PRP I)) (VP (VBD saw) (NP (NNP Smith))) (. .)). Semantic analyzer transforms this into [S [*AGENT* I] [*MEETING* saw] [*PERSON* Smith] [*PUNCTUATION* .].

Natural Language Processor

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Co-reference Resolution

- The meanings of individual sentences that depend on other sentences in the document are resolved.
  - Example: In the text, “I saw Smith. He was with Adams.” the pronoun “He” is resolved to refer to “Smith.”

Natural Language Processor

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Entity Resolution

- Multiple words/phrases refer to the same entity.
  - Example: In the text, "I saw John Smith. Jane Adams was with John." the name "John Smith" and "Smith" are referring to the same entity.

Natural Language Processor

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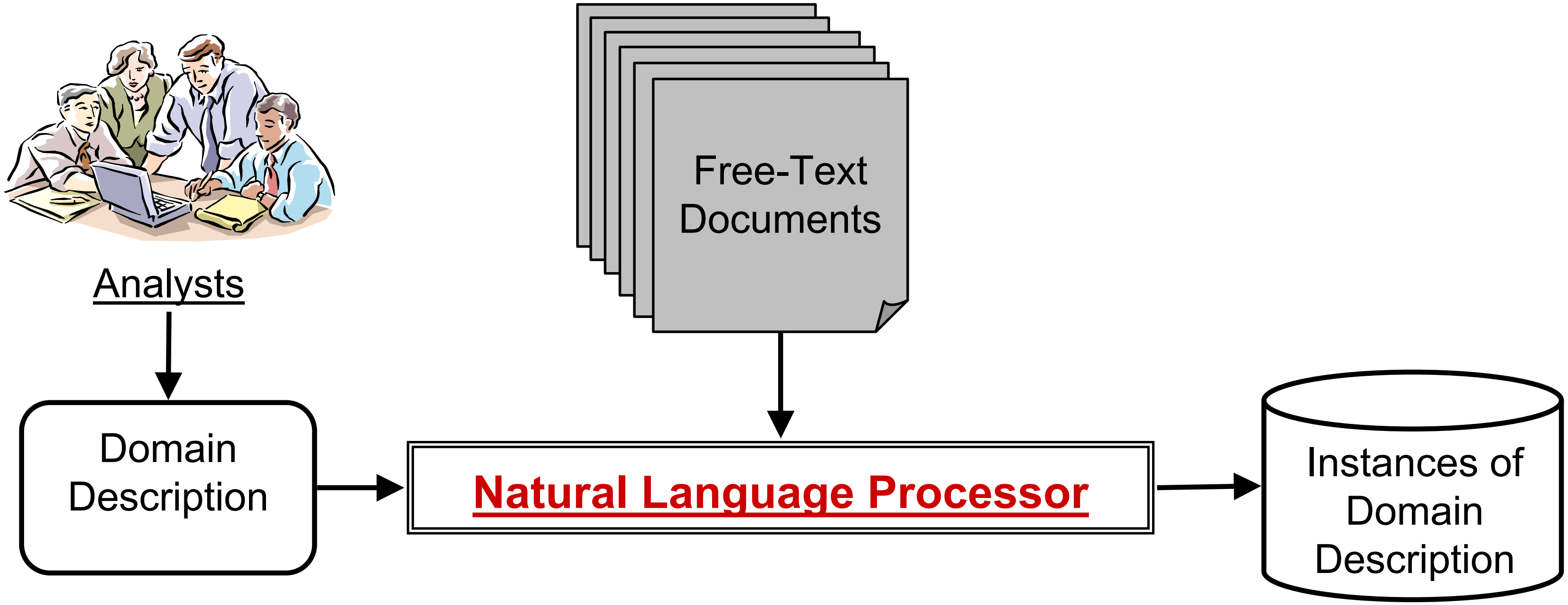
Evaluation Metrics For Natural Language Processor



Analysts

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- **Accuracy = (TP + TN) / (TP + TN + FP + FN)**
- **Recall = TP / (TP + FN)**
- **Precision = TP / (TP + FP)**
- $\mathbf{F_1 = (2 \times Precision \times Recall) / (Precision + Recall)}$

Accomplishments

- Wrote a pre-processor for converting IOAC’s text documents into meta data (*i.e.*, semi-structured text) and articles (*i.e.*, free-text)
- Examined several existing morphological and syntactic analyzers
  - *Stanford Lexical Parser*
  - *Marmot*
  - *Brill’s Tagger*

Natural Language Processor

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Future Plans

- Solve current problems with state-of-the-art syntactic analyzer
  - Example: Handling of long sentences (> 43 words)
- Examination of state-of-the-art semantic analyzers, co-reference solvers, and entity resolution systems
- Solve forthcoming problems with semantic analyzers, co-reference solvers, and entity resolution systems
- Develop a prototype natural language processor for IOAC by October 1, 2004

Natural Language Processor

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Conclusion

- **Problem:**
  - Transform free-text documents into a semantic data structures that represents the topics in which analysts are interested
- **Solution:**
  - Implement a natural language processor containing: (1) morphological analyzer, (2) syntactic analyzer, (3) semantic analyzer, (4) co-reference solver, (5) entity resolution system
- **Benefits:**
  - Allows for subsequent discovery of non-trivial, embedded, and novel information in free-text documents

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